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(54) **STEERING SYSTEM FOR MOTOR VEHICLE**

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(52) **U.S. Cl.** **701/41**; 701/43; 180/443; 180/446

(58) **Field of Search** 701/41, 43, 36; 180/402, 403, 412, 413, 421–423, 443–446

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(57) **ABSTRACT**

A Steering system for a motor vehicle is provided. The system is provided with a principal steering actuator for applying a driving force to a steering mechanism; an auxiliary steering actuator capable of applying a driving force to the steering mechanism; a counter force actuator for applying a counter force to an operation member; a principal steering control section; an auxiliary steering control section; a counter force control section; first and second vehicle condition sensors; and a main controller for comprehensively controlling the control sections. An output signal of the first vehicle condition sensor is inputted to the main controller through a first vehicle condition signal line; and an output signal of the second vehicle condition sensor is inputted, through a second vehicle condition signal line, to at least one of the control sections.

14 Claims, 3 Drawing Sheets

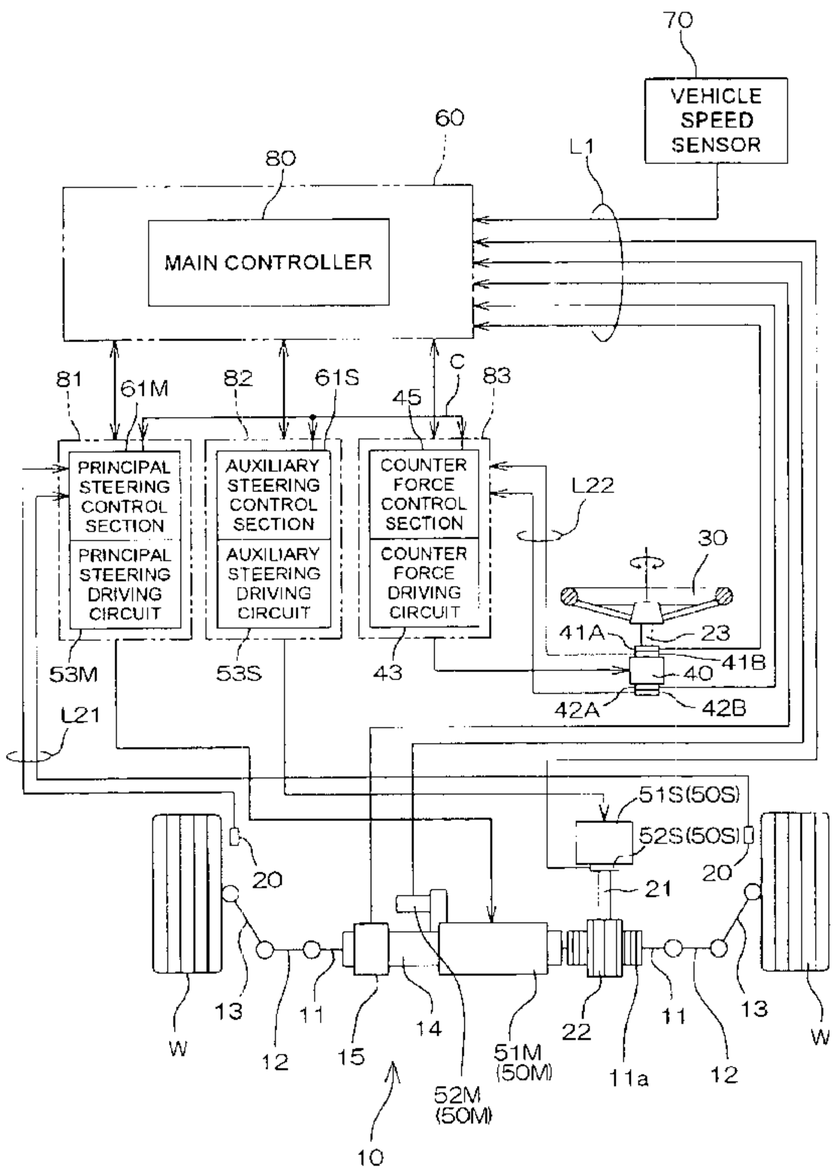


FIG. 1

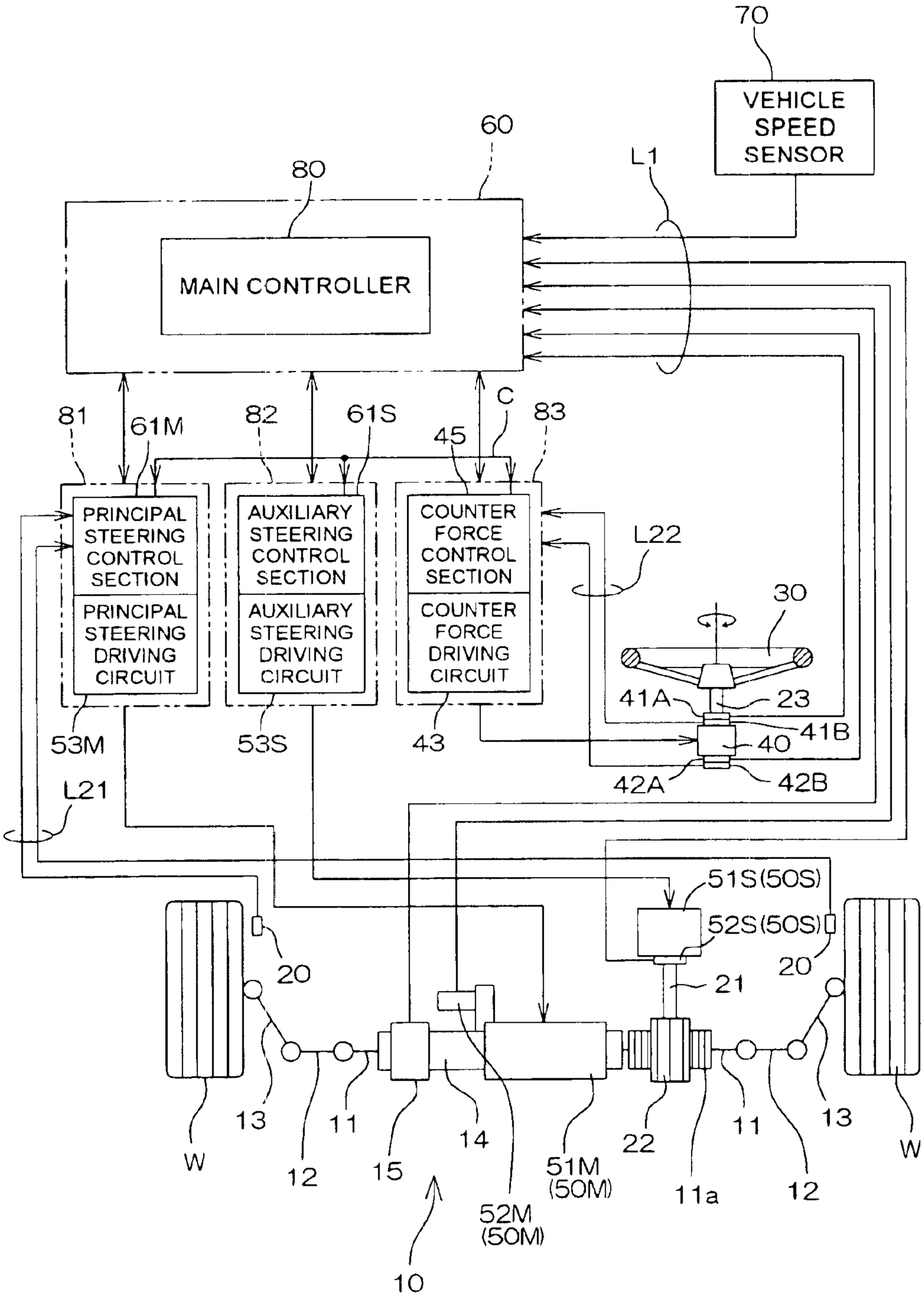
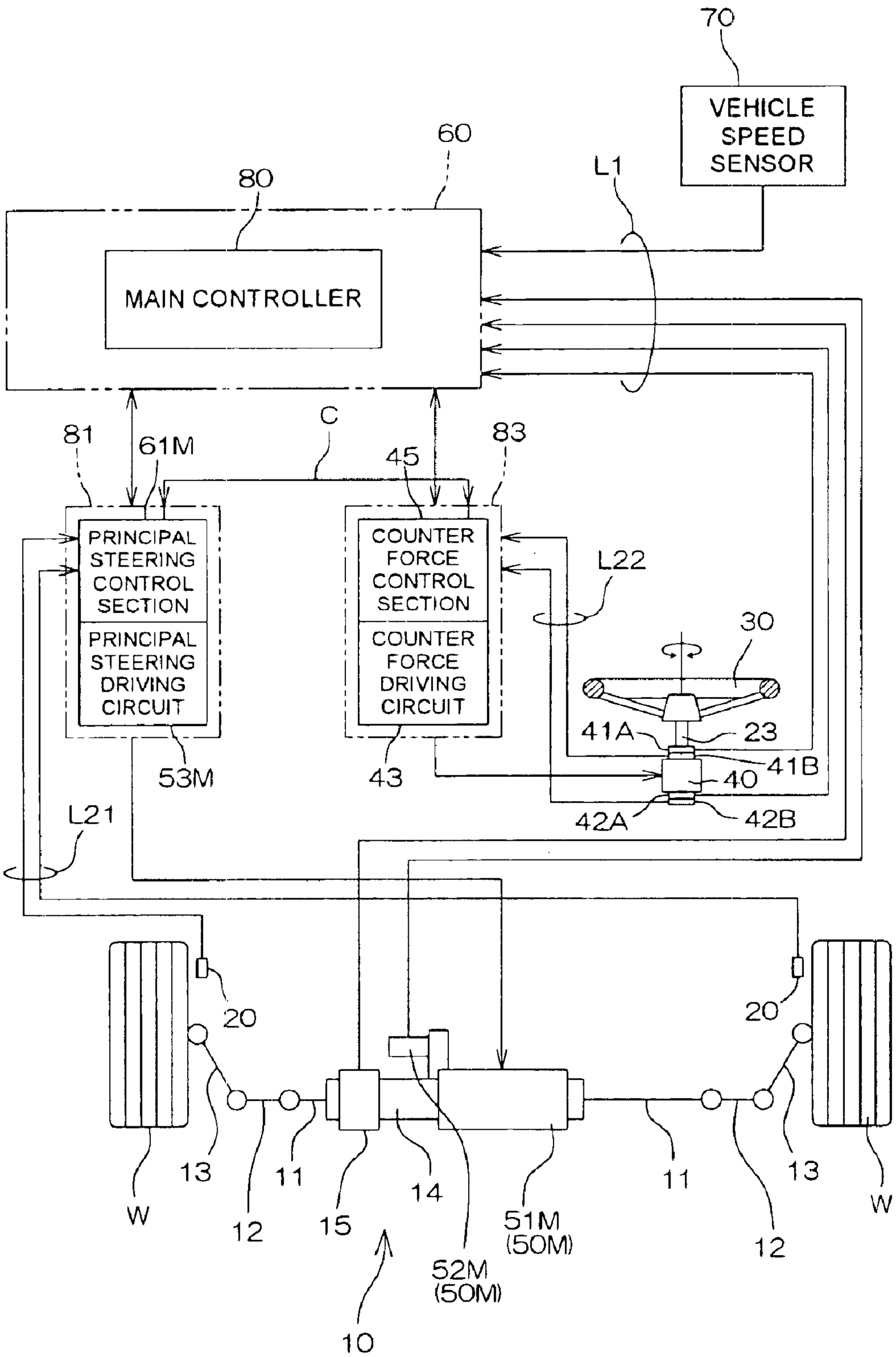

70
VEHICLE SPEED SENSOR
60
80
L1
MAIN CONTROLLER
81
61M
82
61S
C
45
83
PRINCIPAL STEERING CONTROL SECTION
PRINCIPAL STEERING DRIVING CIRCUIT
AUXILIARY STEERING CONTROL SECTION
AUXILIARY STEERING DRIVING CIRCUIT
COUNTER FORCE CONTROL SECTION
COUNTER FORCE DRIVING CIRCUIT
L22
30
41A
23
41B
40
42A
42B
53M
53S
43
L21
51S(50S)
52S(50S)
20
21
W
13
12
11
15
14
51M (50M)
52M (50M)
10
22
11a

FIG. 2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MAIN CONTROLLER
81
61M
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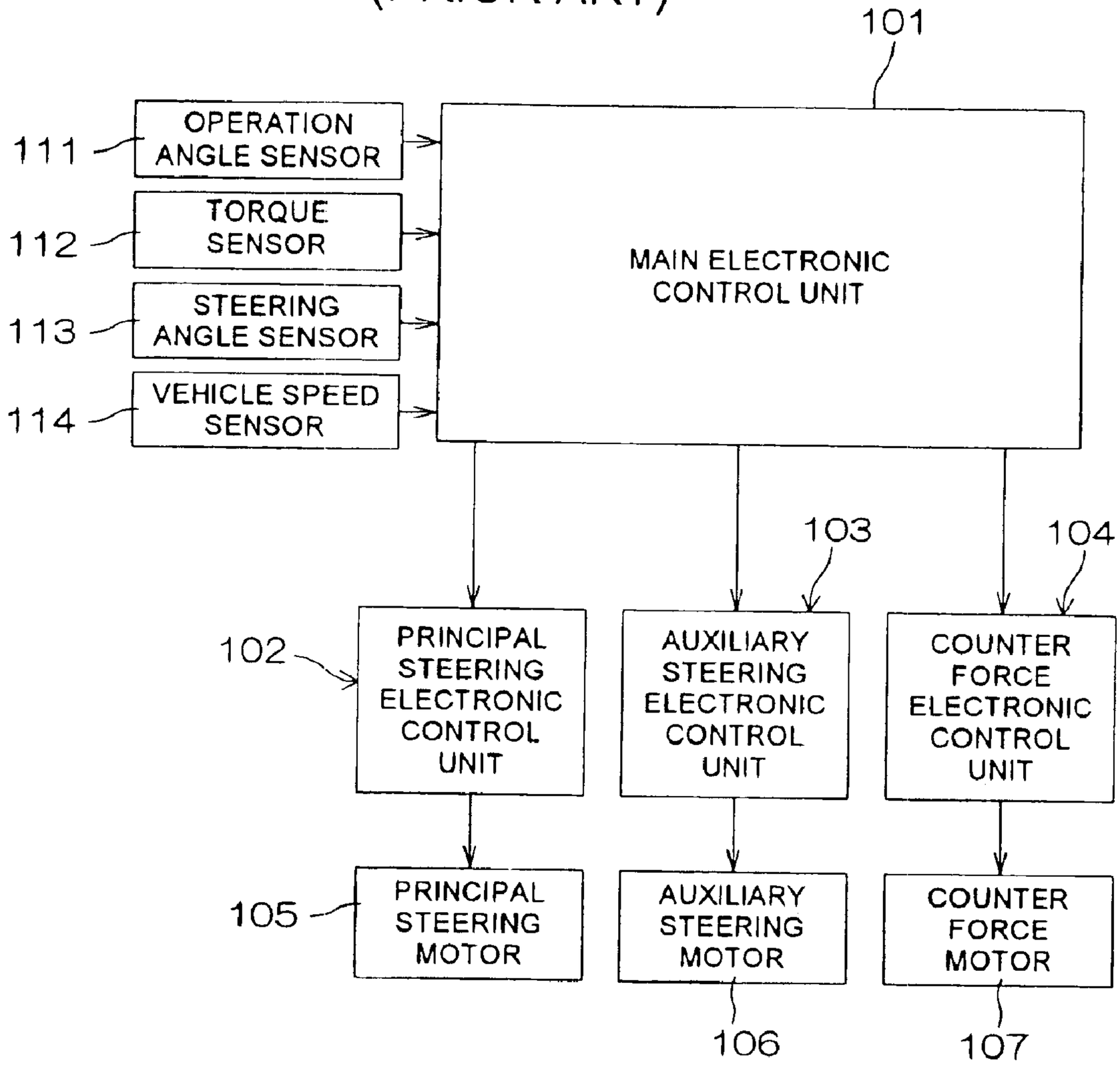
45
83
PRINCIPAL STEERING CONTROL SECTION
PRINCIPAL STEERING DRIVING CIRCUIT
COUNTER FORCE CONTROL SECTION
COUNTER FORCE DRIVING CIRCUIT
L22
30
41A
23
41B
40
42A
42B
53M
43
L21
20
20
13
11
15
14
51M (50M)
52M (50M)
11
13
12
12
W
W
10

FIG. 3
(PRIOR ART)



STEERING SYSTEM FOR MOTOR VEHICLE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a motor vehicle steering system which is adapted to drive a steering mechanism on the basis of the operation of an operation member such as a steering wheel for turning steerable vehicle wheels.

2. Description of Related Art

A steering system (so-called "steer-by-wire system") for a motor vehicle has been proposed, which has no mechanical coupling between a steering wheel and a steering mechanism for turning steerable vehicle wheels, and is adapted to detect the direction and amount of the operation of the steering wheel and apply a driving force to the steering mechanism from a steering actuator such as an electric motor on the basis of the results of the detection.

With this arrangement, a ratio (gear ratio) between the turning amount of the steerable vehicle wheels and the operation amount of the steering wheel can flexibly be changed according to the traveling state of the motor vehicle for improvement of the maneuverability of the motor vehicle. In addition, the aforesaid arrangement is advantageous in that the upward thrust of the steering wheel can be prevented at collision of the motor vehicle and in that the steering wheel can more flexibly be located.

FIG. **3** is a block diagram illustrating the electrical construction of the steer-by-wire system. Detection signals such as indicative of the direction and amount of the operation of the steering wheel are inputted to a main electronic control unit (ECU) **101**. A principal steering motor **105** and an auxiliary steering motor **106** are connected to the steering mechanism, and a counter force motor **107** is connected to the steering wheel. The principal steering motor **105** and the auxiliary steering motor **106** are each adapted to apply the driving force to the steering mechanism for turning the steerable vehicle wheels. The auxiliary steering motor **106** is operative to apply the driving force to the steering mechanism when the principal steering motor **105** and/or its control system malfunction. The counter force motor **107** applies a counter force to the steering wheel according to a reaction force from a road surface.

The principal steering motor **105** is controlled to be driven by a principal steering electronic control unit **102**, and the auxiliary steering motor **106** is controlled to be driven by an auxiliary steering electronic control unit **103**. The counter force motor **107** is controlled to be driven by a counter force electronic control unit **104**. The principal steering electronic control unit **102**, the auxiliary steering electronic control unit **103** and the counter force electronic control unit **104** are comprehensively controlled by the main electronic control unit **101**.

Detection signals are inputted to the main electronic control unit **101** from an operation angle sensor **111** for detecting the operation angle of the steering wheel, a torque sensor **112** for detecting an operation torque applied to the steering wheel, a steering angle sensor **113** for detecting the turning angle of the steerable vehicle wheels and a vehicle speed sensor **114** for detecting the speed of the motor vehicle (vehicle speed).

The main electronic control unit **101** controls the principal steering electronic control unit **102**, the auxiliary steering electronic control unit **103** and the counter force electronic control unit **104** on the basis of the detection signals from the sensors **111** to **114**. That is, the main electronic control unit **101** transmits necessary ones of the detection signals from the sensors **111** to **114** to the principal steering electronic control unit **102**, the auxiliary steering electronic control unit **103** and the counter force electronic control unit **104**, and generates control commands for controlling the electronic control units **102** to **104**.

Thus, the steering force is properly transmitted from the principal steering motor **105** to the steering mechanism according to the operation of the steering wheel, and the counter force is properly transmitted from the counter force motor **107** to the steering wheel according to the reaction force from the road surface. If the principal steering electronic control unit **102**, the principal steering motor **105** or the like malfunctions, the auxiliary steering electronic control unit **103** properly controls the auxiliary steering motor **106** upon reception of a control command from the main electronic control unit **101**.

With the aforesaid arrangement, however, the detection signals from the sensors **111** to **114** which detect the steering conditions of the motor vehicle are inputted only to the main electronic control unit **101**, but not inputted directly to the principal steering electronic control unit **102**, the auxiliary steering electronic control unit **103** and the counter force electronic control unit **104**.

Therefore, the detection signals from the sensors **111** to **114** are not transmitted to the electronic control units **102**, **103**, **104**, if the main electronic control unit **101** malfunctions. This makes it impossible to properly control the principal steering motor **105**, the auxiliary steering motor **106** and the counter force motor **107**.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a steering system for a motor vehicle, which is capable of properly performing a control operation on the basis of vehicle condition signals related to the steering conditions of the motor vehicle even if a main electronic control unit malfunctions.

In accordance with one aspect of the present invention, there is provided a steering system for a motor vehicle, which comprises: an operation member for steering the motor vehicle; a steering mechanism for turning steerable vehicle wheels according to operation of the operation member; a principal steering actuator for applying a driving force to the steering mechanism; an auxiliary steering actuator capable of applying a driving force to the steering mechanism; a counter force actuator for applying a counter force to the operation member according to a reaction force from a road surface; a principal steering control section for controlling the principal steering actuator; an auxiliary steering control section for controlling the auxiliary steering actuator; a counter force control section for controlling the counter force actuator; first and second vehicle condition sensors for detecting vehicle conditions related to steering control of the motor vehicle; a main controller for comprehensively controlling the principal steering control section, the auxiliary steering control section and the counter force control section; a first vehicle condition signal line through which an output signal of the first vehicle condition sensor is inputted to the main controller; and a second vehicle condition signal line through which an output signal of the second vehicle condition sensor is inputted to at least one of the principal steering control section, the auxiliary steering control section and the counter force control section.

With this arrangement, when the main controller malfunctions, a control operation (for controlling the prin-

cipal steering actuator or the auxiliary steering actuator and the counter force actuator) can thereafter continuously be performed properly according to the vehicle conditions by the principal steering control section, the auxiliary steering control section or the counter force control section which receives the output signal of the second vehicle condition sensor. This improves the reliability of the motor vehicle steering system.

The motor vehicle steering system preferably further comprises a control signal line through which a control signal is inputted from the at least one of the principal steering control section, the auxiliary steering control section and the counter force control section which receives the output signal of the second vehicle condition sensor inputted thereto through the second vehicle condition signal line to the other control sections (exclusive of the main controller).

The at least one of the principal steering control section, the auxiliary steering control section and the counter force control section which receives the output signal of the second vehicle condition sensor inputted thereto through the second vehicle condition signal line preferably inputs the control signal to the other control sections (exclusive of the main controller) through the control signal line, when the main controller malfunctions.

With this arrangement, the control section which receives the output signal of the second vehicle condition sensor can control the other control sections (and further control the principal steering actuator or the counter force actuator via the other control sections). Therefore, the control operation can properly be performed when the main controller malfunctions.

The at least one of the principal steering control section, the auxiliary steering control section and the counter force control section which receives the output signal of the second vehicle condition sensor inputted thereto through the second vehicle condition signal line preferably performs an open loop control operation on the other control sections (exclusive of the main controller) by inputting the control signal to the other control sections through the control signal line.

With this arrangement, the control of the other control sections by the at least one control section which receives the output signal of the second vehicle condition sensor (and the control of the principal steering actuator or the counter force actuator via the other control sections) is performed on an open loop basis. Therefore, the control system can be simplified, so that the costs can correspondingly be reduced.

In accordance with another aspect of the present invention, there is provided a steering system for a motor vehicle, which comprises: an operation member for steering the motor vehicle; a steering mechanism for turning steerable vehicle wheels according to operation of the operation member; a principal steering actuator for applying a driving force to the steering mechanism; a counter force actuator for applying a counter force to the operation member according to a reaction force from a road surface; a principal steering control section for controlling the principal steering actuator; a counter force control section for controlling the counter force actuator; first and second vehicle condition sensors for detecting vehicle conditions related to steering control of the motor vehicle; a main controller for comprehensively controlling the principal steering control section and the counter force control section; a first vehicle condition signal line through which an output signal of the first vehicle condition sensor is inputted to the main controller; and a second vehicle condition signal line through which an output signal of the second vehicle condition sensor is inputted to at least one of the principal steering control section and the counter force control section.

With this arrangement, even when the main controller malfunctions, a control operation (for controlling the principal steering actuator and the counter force actuator) can thereafter continuously be performed properly according to the vehicle conditions by the principal steering control section or the counter force control section which receives the output signal of the second vehicle condition sensor.

The motor vehicle steering system preferably further comprises a control signal line through which a control signal is inputted from the one of the principal steering control section and the counter force control section which receives the output signal of the second vehicle condition sensor inputted thereto through the second vehicle condition signal line to the other control section (exclusive of the main controller).

The one of the principal steering control section and the counter force control section which receives the output signal of the second vehicle condition sensor inputted thereto through the second vehicle condition signal line preferably inputs the control signal to the other control section (exclusive of the main controller) through the control signal line, when the main controller malfunctions.

The one of the principal steering control section and the counter force control section which receives the output signal of the second vehicle condition sensor inputted thereto through the second vehicle condition signal line preferably performs an open loop control operation on the other control section (exclusive of the main controller) by inputting the control signal to the other control section through the control signal line.

The foregoing and other objects, features and effects of the present invention will become more apparent from the following description of the preferred embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a conceptual diagram for explaining the basic construction of a motor vehicle steering system according to a first embodiment of the present invention;

FIG. **2** is a conceptual diagram for explaining the basic construction of a motor vehicle steering system according to a second embodiment of the present invention; and

FIG. **3** is a block diagram for explaining the prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** is a conceptual diagram for explaining the basic construction of a steering system for a motor vehicle in accordance with a first embodiment of the present invention. The motor vehicle steering system includes a steering mechanism **10** for causing a pair of steerable vehicle wheels (typically, front vehicle wheels) W, W to perform a steering operation, and a steering wheel **30** which has no mechanical coupling with the steering mechanism **10**.

The motor vehicle steering system has a dual steering driving system including a principal steering driving system **50**M and an auxiliary steering driving system **50**S for driving the steering mechanism **10**. The principal steering driving system **50**M includes a principal steering actuator **51**M and a principal rotation angle sensor **52**M for detecting the rotation angle of the principal steering actuator **51**M. On the other hand, the auxiliary steering driving system **50**S

includes an auxiliary steering actuator **51**S and an auxiliary rotation angle sensor **52**S for detecting the rotation angle of the auxiliary steering actuator **51**S. The principal steering actuator **51**M and the auxiliary steering actuator **51**S are each constituted, for example, by an electric motor.

The steering mechanism **10** includes a steering shaft **11** extending transversely of a vehicle body and knuckle arms **13**, **13** coupled to opposite ends of the steering shaft **11** via tie rods **12**, **12** for supporting the steerable vehicle wheels W, W. The steering shaft **11** is supported by a housing **14** slidably along the axis thereof, and the principal steering actuator **51**M is coaxially incorporated in the midst of the steering shaft **11**.

The steering shaft **11** has a rack gear **11***a* formed around a part thereof, and the rack gear **11***a* is threadingly engaged with a pinion gear **22** provided at an end of a shaft **21**. The shaft **21** is coupled to the auxiliary steering actuator **51**S, so that a driving force generated by the auxiliary steering actuator **51**S is inputted to the shaft **21**.

With this arrangement, when the principal steering actuator **51**M is driven, the rotational movement of the principal steering actuator **51**M is converted into the sliding movement of the steering shaft **11** by a movement converting mechanism such as including a ball thread, whereby the steerable vehicle wheels W, W are turned by the sliding movement of the steering shaft **11**. When the auxiliary steering actuator **51**S is driven, the rotational movement of the shaft **21** caused by the auxiliary steering actuator **51**S is converted into the sliding movement of the steering shaft **11** by the pinion gear **22** and the rack gear **11***a*, whereby the steerable vehicle wheels W, W are turned by the sliding movement of the steering shaft **11**.

A counter force actuator **40** for applying a counter force to the steering wheel **30** correspondingly to a reaction force from a road surface is coupled to the steering wheel **30**.

The counter force actuator **40** is constituted by an electric motor (e.g., a three-phase brushless motor) which includes a shaft **23** coupled to the steering wheel **30** as its rotation shaft, and a casing of the electric motor is fixed to a proper portion of the vehicle body. A pair of torque sensors **41**A, **41**B for detecting a steering torque inputted from the steering wheel **30** and a pair of operation angle sensors **42**A, **42**B for detecting the operation angle of the steering wheel **30** are provided adjacent the counter force actuator **40**.

The counter force actuator **40**, the principal steering actuator **51**M and the auxiliary steering actuator **51**S are supplied with driving electric currents from driving circuits **43**, **53**M and **53**S, respectively.

Detection signals of the torque sensor **41**A, the operation angle sensor **42**A, the principal rotation angle sensor **52**M and the auxiliary rotation angle sensor **52**S are inputted to a main electronic control unit (ECU) **60** via a signal line L**1**. A steering position sensor **15** for detecting the axial position of the steering shaft **11** is provided in association with the steering shaft **11**, and a detection signal of the steering position sensor **15** is also inputted to the main electronic control unit **60** via the signal line L**1**. A detection signal of a vehicle speed sensor **70** for detecting the speed of the motor vehicle is also inputted to the main electronic control unit **60** via the signal line L**1**.

A principal steering electronic control unit **81** is provided for feedback-controlling the electric current of the principal steering actuator **51**M. The driving circuit (principal steering driving circuit) **53**M for the principal steering actuator **51**M and a principal steering control section **61**M for feedback-controlling the electric current of the principal steering actuator **51**M by applying a control signal to the principal steering driving circuit **53**M are incorporated in the principal steering electronic control unit **81**. The principal steering control section **61**M includes a CPU (central processing unit).

Detection signals from vehicle wheel speed sensors **20** provided in association with the steerable vehicle wheels W or the other vehicle wheels in the motor vehicle are inputted to the control section **61**M not via the main electronic control unit **60** but via a signal line L**21**.

An auxiliary steering electronic control unit **82** is provided for feedback-controlling the electric current of the auxiliary steering actuator **51**S. The driving circuit (auxiliary steering driving circuit) **53**S for the auxiliary steering actuator **51**S and an auxiliary steering control section **61**S for feedback-controlling the electric current of the auxiliary steering actuator **51**S by applying a control signal to the auxiliary steering driving circuit **53**S are incorporated in the auxiliary steering electronic control unit **82**. The auxiliary steering control section **61**S includes a CPU.

A counter force electronic control unit **83** is provided for feedback-controlling the electric current of the counter force actuator **40**. The driving circuit (counter force driving circuit) **43** for the counter force actuator **40** and a counter force control section **45** for feedback-controlling the electric current of the counter force actuator **40** by applying a control signal to the counter force driving circuit **43** are incorporated in the counter force electronic control unit **83**. The counter force control section **45** includes a CPU.

Detection signals from the torque sensor **41**B and the operation angle sensor **42**B are inputted to the counter force actuator **40** not via the main electronic control unit **60** but via a signal line L**22**.

The principal steering control section **61**M, the auxiliary steering control section **61**S and the counter force control section **45** are connected to each other via a control signal line C, so that control signals can be applied from one of the control sections to the other control sections.

The main electronic control unit **60** has a main controller **80** therein for comprehensively controlling the entire steering system. The main controller **80** includes a CPU, and monitors the operation of the principal steering electronic control unit **81**. When the principal steering driving system **50**M including the principal steering electronic control unit **81** malfunctions, the driving control of the auxiliary steering actuator **51**S by the auxiliary steering electronic control unit **82** is started.

The main controller **80** comprehensively controls the principal steering control section **61**M, the auxiliary steering control section **61**S and the counter force control section **45** on the basis of the signals inputted from the sensors **41**A, **42**A, **52**M, **52**S, **15**, **70**, and transmits necessary ones of the sensor signals to the control sections **61**M, **61**S, **45**.

The malfunction of the main electronic control unit **60**, if occurring, is detected by at least one of the principal steering control section **61**M, the auxiliary steering control section **61**S and the counter force control section **45**. Thus, the principal steering control section **61**M, the auxiliary steering control section **61**S and the counter force control section **45** start performing a control operation independently of a control command from the main controller **80**.

For example, the principal steering control section **61**M computes the vehicle speed on the basis of the detection signals from the vehicle wheel speed sensors **20**, **20**. Further, the principal steering control section **61**M acquires steering

torque data (a value detected by the torque sensor **41**B) and operation angle data (a value detected by the operation angle sensor **42**B) from the counter force control section **45** via the control signal line C. The principal steering control section **61**M controls the driving of the principal steering actuator **51**M on the basis of the vehicle speed data, the steering torque data and the operation angle data, and applies a control command to the counter force control section **45** via the control signal line C for controlling the counter force actuator **40**.

Instead of the principal steering control section **61**M, the counter force control section **45** may perform the aforesaid control operation. In this case, the counter force control section **45** acquires the vehicle speed data from the principal steering control section **61**M via the control signal line C. On the basis of the vehicle speed data, and the steering torque data and the operation angle data represented by signals inputted through the signal line **L22**, the counter force control section **45** controls the driving of the counter force actuator **40**, and applies a control command to the principal steering control section **61**M via the control signal line C for the driving control of the principal steering actuator **51**M.

Further, the auxiliary steering control section **61**S may perform the aforesaid control operation. That is, the auxiliary steering control section **61**S acquires the vehicle speed data from the principal steering control section **61**M via the control signal line C, and acquires the steering torque data and the operation angle data from the counter force control section **45** via the control signal line C. On the basis of the data thus acquired, the auxiliary steering control section **61**S applies a control command to the principal steering control section **61**M via the control signal line C for the driving control of the principal steering actuator **51**M, and applies a control command to the counter force control section **45** via the control signal line C for the driving control of the counter force actuator **40**.

In either of the aforesaid cases, the principal steering actuator **51**M and the counter force actuator **40** are preferably controlled on an open loop basis without the feedback. Thus, the control system can be simplified.

According to this embodiment, the principal steering control section **61**M, the auxiliary steering control section **61**S or the counter force control section **45** can perform the control operation on the basis of the detection signals of the sensors **20**, **41**B, **42**B, as described above, when the main electronic control unit **60** malfunctions. Thus, the control operation can thereafter continuously be performed properly according to the conditions of the motor vehicle, even if the main electronic control unit **60** malfunctions.

In accordance with a modification of this embodiment, all the sensor detection signals required when the main electronic control unit **60** malfunctions may collectively be inputted to one of the principal steering control section **61**M, the auxiliary steering control section **61**S and the counter force control section **45**. In this case, the one control section may perform a comprehensive control operation at the malfunction of the main electronic control unit **60**.

FIG. **2** is a conceptual diagram for explaining the construction of a motor vehicle steering system according to a second embodiment of the present invention. In FIG. **2**, components corresponding to those shown in FIG. **1** are denoted by the same reference characters as in FIG. **1**.

This embodiment has substantially the same construction as the first embodiment, except that the auxiliary steering actuator and associated components are not provided. That is, the driving of the principal steering actuator **51**M and the counter force actuator **40** can properly be controlled on the basis of the detection signals inputted to the principal steering control section **61**M or the counter force control section **45** from the sensors **41**B, **42**B, **20** via the signal lines **L21**, **L22**, if the main electronic control unit **60** malfunctions.

Thus, this embodiment provides the same effects as the first embodiment described above. Similarly to the first embodiment, the principal steering actuator **51**M and the counter force actuator **40** are preferably controlled on an open loop basis for the simplification of the control system.

The second embodiment may be modified in the same manner as the first embodiment.

While the two embodiments of the present invention have thus been described, the invention may be embodied in any other ways. Although the embodiments described above are directed to the case where the steering wheel **30** is employed as the operation member, other types of operation members such as a lever and a pedal may be employed.

Although the steer-by-wire (SBW) system is employed as an example of the motor vehicle steering system in the embodiments described above, the invention is not limited to the steer-by-wire system. The invention is widely applicable to motor vehicle steering systems which are capable of changing a relationship between the operation angle of the operation member and the steering angle of the steering mechanism. For example, the invention may be applied to a steering system (so-called "variable gear-ratio steering (VGS) system") which is capable of changing the ratio (gear ratio) of the steering angle of the steering mechanism to the operation angle of the operation member and has mechanical coupling between the operation member and the steering mechanism.

While the present invention has been described in detail by way of the embodiments thereof, it should be understood that the foregoing disclosure is merely illustrative of the technical principles of the present invention but not limitative of the same. The spirit and scope of the present invention are to be limited only by the appended claims.

This application corresponds to Japanese Patent Application No. 2002-87959 filed with the Japanese Patent Office on Mar. 27, 2002, the disclosure thereof being incorporated herein by reference.

What is claimed is:

1. A steering system for a motor vehicle, comprising:

an operation member for steering the motor vehicle;

a steering mechanism for turning steerable vehicle wheels according to operation of the operation member;

a principal steering actuator for applying a driving force to the steering mechanism;

an auxiliary steering actuator capable of applying a driving force to the steering mechanism;

a counter force actuator for applying a counter force to the operation member according to a reaction force from a road surface;

a principal steering control section for controlling the principal steering actuator;

an auxiliary steering control section for controlling the auxiliary steering actuator;

a counter force control section for controlling the counter force actuator;

a main controller for comprehensively controlling the principal steering control section, the auxiliary steering control section and the counter force control section;

a first vehicle condition sensor for detecting a vehicle condition related to steering control of the motor vehicle, and generating an output signal which is inputted only to the main controller;

a second vehicle condition sensor for detecting the same vehicle condition as the first vehicle condition sensor, and generating an output signal which is inputted only to at least one of the principal steering control section, the auxiliary steering control section and the counter force control section; and

a control signal line interconnecting the principal steering control section, the auxiliary steering control section and the counter force control section,

wherein the at least one of the principal steering control section, the auxiliary steering control section and the counter force control section which receives the output signal of the second vehicle condition sensor, is adapted to process the output signal of the second vehicle condition sensor and input a control signal through the control signal line to the other control sections.

2. A motor vehicle steering system as set forth in claim **1**, wherein the at least one of the principal steering control section, the auxiliary steering control section and the counter force control section which receives the output signal of the second vehicle condition sensor inputted thereto inputs the control signal to the other control sections through the control signal line, when the main controller malfunctions.

3. A motor vehicle steering system as set forth in claim **2**, wherein the at least one of the principal steering control section, the auxiliary steering control section and the counter force control section which receives the output signal of the second vehicle condition sensor inputted thereto performs an open loop control operation on the other control sections by inputting the control signal to the other control sections through the control signal line.

4. A steering system for a motor vehicle, comprising:

an operation member for steering the motor vehicle;

a steering mechanism for turning steerable vehicle wheels according to operation of the operation member;

a principal steering actuator for applying a driving force to the steering mechanism;

a counter force actuator for applying a counter force to the operation member according to a reaction force from a road surface;

a principal steering control section for controlling the principal steering actuator;

a counter force control section for controlling the counter force actuator;

a main controller for comprehensively controlling the principal steering control section and the counter force control section;

a first vehicle condition sensor for detecting a vehicle condition related to steering control of the motor vehicle, and generating an output signal which is inputted to only to the main controller;

a second vehicle condition sensor for detecting the same vehicle condition as the first vehicle condition sensor, and generating an output signal which is inputted only to at least one of the principal steering control section and the counter force control section; and

a control signal line interconnecting the principal steering control section and the counter force control section,

wherein the one of the principal steering control section and the counter force control section which receives the output signal of the second vehicle condition sensor, is adapted to process the output signal of the second vehicle condition sensor and input a control signal through the control signal line to the other control section.

5. A motor vehicle steering system as set forth in claim **4**, wherein the one of the principal steering control section and the counter force control section which receives the output signal of the second vehicle condition sensor inputted thereto inputs the control signal to the other control section through the control signal line, when the main controller malfunctions.

6. A motor vehicle steering system as set forth in claim **5**, wherein the one of the principal steering control section and the counter force control section which receives the output signal of the second vehicle condition sensor inputted thereto performs an open loop control operation on the other control section by inputting the control signal to the other control section through the control signal line.

7. A steering system for a motor vehicle, comprising:

an operation member for steering the motor vehicle;

a steering mechanism for turning steerable vehicle wheels according to operation of the operation member;

a principal steering actuator for applying a driving force to the steering mechanism;

a counter force actuator for applying a counter force to the operation member according to a reaction force from a road surface;

a principal steering control section for controlling the principal steering actuator;

a counter force control section for controlling the counter force actuator;

a main controller for comprehensively controlling the principal steering control section and the counter force control section;

a first vehicle condition sensor for detecting a first vehicle condition related to steering control of the motor vehicle, and generating an output signal which is inputted only to the main controller;

a second vehicle condition sensor for detecting a second vehicle condition related to steering control of the motor vehicle, and generating an output signal which is inputted only to one of the principal steering control section and the counter force control section; and

a third vehicle condition sensor for detecting a third vehicle condition related to steering control of the motor vehicle, and generating an output signal which is inputted only to the one of the principal steering control section and the counter force control section which is other than the one control section to which the output signal of the second vehicle condition sensor is inputted.

8. A motor vehicle steering system as set forth in claim **7**, further comprising a control signal line interconnecting the principal steering control section and the counter force control section,

wherein the one of the principal steering control section and the counter force control section which receives the output signal of the second vehicle condition sensor, is adapted to process the output signal of the second vehicle condition sensor and input a control signal through the control signal line to the other control section.

9. A motor vehicle steering system as set forth in claim **8**, wherein the one of the principal steering control section and

the counter force control section which receives the output signal of the second vehicle condition sensor inputted thereto inputs the control signal to the other control section through the control signal line, when the main controller malfunctions.

10. A motor vehicle steering system as set forth in claim **9**, wherein the one of the principal steering control section and the counter force control section which receives the output signal of the second vehicle condition sensor inputted thereto performs an open loop control operation on the other control section by inputting the control signal to the other control section through the control signal line.

11. A motor vehicle steering system as set forth in claim **7**, further comprising a control signal line interconnecting the principal steering control section and the counter force control section,

wherein the one of the principal steering control section and the counter force control section which receives the output signal of the third vehicle condition sensor, is adapted to process the output signal of the third vehicle condition sensor and input a control signal through the control signal line to the other control section.

12. A motor vehicle steering system as set forth in claim **11**, wherein the one of the principal steering control section and the counter force control section which receives the output signal of the third vehicle condition sensor inputted thereto inputs the control signal to the other control section through the control signal line, when the main controller malfunctions.

13. A motor vehicle steering system as set forth in claim **12**, wherein the one of the principal steering control section and the counter force control section which receives the output signal of the third vehicle condition sensor inputted thereto performs an open loop control operation on the other control section by inputting the control signal to the other control section through the control signal line.

14. A motor vehicle steering system as set forth in claim **7**, wherein the first vehicle condition being sensed is the same as one of the second vehicle condition and the third vehicle condition.

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